

Is More More, or is More Less?

IB Math Studies Survey Project

How strong, if existent, is the correlation between the number of advanced level (AP/IB/Honors) courses that a student takes, and the number of hours spent on homework per class per week?

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Statement of Task:

I began my junior year (2009-2010) with the usual day of picking up several books from subjects ranging from Honors Spanish to IB year one Psychology. As I prepared these books and other necessary school supplies I came upon a note from Upper Arlington High School noting that the limit imposed by Principal Kip Greenhill on homework for students was to be no more than three hours a week per class. I stared in disbelief, as this was only to be around 26 minutes per week including the weekend. As I began to attend the aforementioned range of classes it appeared as though a pattern began to form with my post-class schoolwork. There was a colloquial "roller-coaster" of homework, one week it appeared that the workload far exceeded the three hours and the next week it appeared as though the workload was far below the maximum of three hours. I began to contemplate whether or not others were experiencing the same level of homework. The purpose of this project will be to determine the opinion of the student body taking advanced (IB/AP or Honors) classes, in regards to whether or not there is a correlation between the number of advanced classes, and the number of hours of homework per class per week that students were experiencing.

I don't
get this
calculation.

Research Question:

How strong, if existent, is the correlation between the number of advanced level (AP/IB/Honors) courses that a student takes, and the number of hours spent on homework per class per week?

Procedure:

The initial and main tool for gathering the information needed to obtain the answer to the research question will be a survey of students grades 10-12 and teachers teaching advanced classes. The first survey going to students will be a simple one with four questions.

One "What is your sex?" Two, "How many advanced level classes (AP/IB or Honors) are you currently enrolled in? Students were given options of "0", "1", "2", "3", "4", "5", "6", or "7+" courses." Three "If you marked 1 or more on the previous question, how many hours PER CLASS PER WEEK would you say you spent on homework (average hours)?" Students were given options of "Less than 1 hour", "1", "2", "3", "4", or "4+". Four, "If you marked 3 or above on the previous question, would you say that the homework load was self imposed (non-assigned or extra studying/homework) or teacher imposed (assigned homework or studying)?"

I added the final question in order to create an opportunity for further analysis of the data, should there be a strong correlation between the two previously discussed pieces, then a correlation could be determined on whether there was a correlation between people who said that they were given the majority of their homework by the teachers and the number of classes they (the students). No names will be used in these surveys in order to attempt to eliminate the confounding variables of social-desirability bias, and participant bias.

} rather
confusing
why?

The total number of surveys taken from students will tally no more than 220 surveys and no less than 200 surveys. I will collect this data by two methods. One, through each class that I attend throughout the day, I will be surveying the students as I may be assured of their participation in at least one advanced level class. Secondly, I will

obtain additional data by asking teachers of advanced classes that I have attended in the past to distribute the voluntary study to their students throughout the day. Utilizing this data I will attempt to hypothesize an answer to the aforementioned question.

I will organize the data in bar graphs, tables, summary tables, frequency tables, and other visual representations of the gained numerical values mentioned above. I will use operations within mathematics learned this year ranging from simple visual data representation to chi-squared tests to linear regression tests to the basic four functions of math. I will attempt to organize and harness all of this data in its many forms to discern a hypothesis in response to the research question.

Survey Results:

In order to be able to statistically analyze this data, all data points for "Hours" that contain characters (i.e. all 4+ have been changed to 5). All data points in that contain characters in "Advanced", for instance 7+ have been changed to 7. After collecting the data from a series of past teachers, as well as from the numerous students in shared advanced classes the data was organized into raw data tables, then subsequent summary tables,

IB-217.htm

		Advanced							Row Summary
		1	2	3	4	5	6	7	
Hours	0	1	6	4	2	0	1	0	14
	1	3	4	4	6	0	0	0	17
	2	3	9	9	5	3	1	0	30
	3	4	15	17	12	3	1	0	52
	4	1	17	18	12	2	4	1	55
	5	8	7	15	9	5	3	0	47
Column Summary		20	58	67	46	13	10	1	215

S1 = count ()

and then bar graphs. Initially the raw data was shown as a raw data table later condensed to a summary frequency table (figure above) in order to be able to properly analyze it. A total number of 215 individual collected surveys were accumulated. A hypothesis could not be determined at this point as it appeared that there is a significantly spread data. The raw data from each one of the surveys is displayed below in a double columned format. Each "Gender" corresponds to one "# of advanced" one "Hours" and one "Self or Teacher [Imposed]". The data set below corresponds to each of the questions mentioned before. The heading "Gender" corresponds to the answers to the survey question "What is your Sex". The heading "Number of advanced" corresponds to the answers to the survey question "How many advanced level classes (AP/IB or Honors) are you currently enrolled in?" The heading "Hours" corresponds to the responses to the survey question "If you marked 1 or more on the previous question, how many hours PER CLASS PER WEEK would you say you spent on homework (average hours)?" The heading "Self or Teacher" corresponds to the responses to the survey question "If you marked 3 or above on the previous question, would you say that the homework load was self imposed (non-assigned or extra studying) or teacher imposed (assigned homework or studying)

Gender	Number of advanced	Hours	Self or Teacher
Female	2	2	N/A

Female		2	4	Self
Female		1	5	Teacher
Male		3	3	Teacher
Male		3	4	Teacher
Female		2	4	Teacher
Female		1	0-1	N/A
Female		3	2	N/A
Female	4+		4	Self
Female		3	4	Teacher
Male	4+		4	Teacher
Male		3	5	Teacher
Male	4+		3	Teacher
Male		1	0-1	N/A
Male		3	4	Teacher
Male		3	5	Teacher
Male	4+		0-1	N/A
Male		2	0-1	N/A
Male		1	0-1	N/A
Male		2	4	Self
Male		2	2	N/A
Male		2	4	Self
Male		3	2	N/A
Female	4+		3	Teacher
Male		3	4	Self
Female	4+		3	Self
Female		3	2	N/A
Male	4+		5	Teacher
Female		1	3	Teacher
Female		3	3	Self
Male		2	2	N/A
Male		1	0-1	N/A
Male		2	0-1	N/A
Female	4+		2	N/A
Female		3	2	N/A
Male		1	2	N/A
Female		3	0-1	N/A
Female	4+		4	Self
Female		2	0-1	N/A
Male	4+		4	Self
Male	4+		3	Self
Male	4+		5	Teacher
Male	4+		4	Teacher

Female		2		4	Teacher
Male	4+			3	Teacher
Female	4+			5	Teacher
Male	4+			3	Teacher
Female	4+		0-1		N/A
Male	4+			4	Self
Male	4+			4	Teacher
Male		3		4	Teacher
Female		2		5	Teacher
Male	4+		0-1		N/A
Female	4+			5	Self
Male	4+			5	Teacher
Male	4+			5	Teacher
Male	4+			4	Self
Female	4+			2	N/A
Female		3		5	Teacher
Male	4+			4	Teacher
Female	4+			5	Teacher
Female	4+			4	Teacher
Female	4+			5	Self
Male		2	0-1		N/A
Male	4+		0-1		N/A
Male		3		3	Teacher
Female		3		4	Self
Male	4+			4	Teacher
Male	4+			3	Self
Male		3		5	Teacher
Male		3		3	Teacher
Female	4+			3	Teacher
Female		2		5	Teacher
Female		2		4	Self
Female		3		5	Teacher
Male	4+			5	Teacher
Female		1		5	Self
Male	4+			4	Teacher
Male	4+			4	Teacher
Male		2		3	Teacher
Male		3		5	Self
Female		3		5	Teacher
Female		2		5	Self
Female		3		4	Teacher
Male		3		3	Teacher

Female	4+		5	Teacher
Male		3	5	Self
Male		2	3	Teacher
Female	4+		3	Teacher
Female		2	4	Teacher
Female	4+		4	Teacher
Male	4+		4	Teacher
Male		3	4	Teacher
Female		2	5	Self
Female		3	5	Teacher
Male		3	4	Self
Female		3	3	Teacher
Female		1	2	N/A
Female		3	4	Teacher
Male		3	3	Teacher
Male		2	4	Teacher
Male	4+	0-1		N/A
Female		3	4	Teacher
Female		2	3	Teacher
Male		2	4	Teacher
Male		2	4	Teacher
Female		3	5	Teacher
Male		2	3	Self
Female		3	3	Teacher
Female		2	5	Teacher
Female		3	4	Teacher
Female		2	3	Teacher
Female		3	5	Teacher
Male		3	0-1	N/A
Female		2	2	Teacher
Female		2	4	Self
Female	4+		3	Self
Female		1	3	Self
Female	4+		4	Self
Male		3	4	Teacher
Male	4+		3	Teacher
Male	4+		5	Teacher
Male	4+		2	N/A
Male		3	0-1	N/A
Female		2	4	Teacher
Female	4+		3	Teacher
Female	4+		5	Teacher

Female	2	3	Teacher
Male	2	5	Teacher
Female	3	2	N/A
Female	3	2	N/A
Male	2	5	Self
Male	2	3	Teacher
Male	1	2	N/A
Male	2	0-1	N/A
Female	3	0-1	N/A
Male	4+	4	Self
Male	2	2	N/A
Male	4+	0-1	N/A
Female	4+	3	Self
Female	3	3	Teacher
Female	2	3	Teacher
Female	3	4	Self
Female	3	3	Self
Female	1	5	Teacher
Male	3	2	N/A
Male	4+	0-1	N/A
Male	3	0-1	N/A
Female	4+	2	N/A
Male	4+	5	Self
Female	2	4	Self
Female	1	3	Self
Female	2	3	Self
Female	3	5	Teacher
Female	4+	2	N/A
Female	4+	2	N/A
Male	4+	0-1	N/A
Male	3	0-1	N/A
Male	3	0-1	N/A
Male	3	5	Teacher
Male	2	3	Teacher
Male	2	3	Teacher
Male	4+	5	Self
Female	3	3	Self
Female	2	0-1	N/A
Female	2	3	Teacher
Male	3	3	Teacher
Male	4+	3	Teacher
Male	4+	5	Teacher

Female		3	4	Teacher
Female		2	3	Teacher
Female		2	2	N/A
Male		3	3	Self
Female	4+		5	Self
Female	4+		4	Teacher
Male	4+		5	Teacher
Male		1	5	Teacher
Female		2	2	N/A
Female		3	4	Self
Female		2	4	Self
Male		2	4	Self
Male		2	4	Self
Female		3	5	Teacher
Male		1	3	Teacher
Female		1	4	Teacher
Female		3	4	Teacher
Female		2	2	N/A
Female		3	0-1	N/A
Male		2	0-1	N/A
Male		2	0-1	N/A
Male		1	5	Self
Male		3	3	Teacher
Male	4+		2	N/A
Female		3	5	Teacher
Female	4+		3	Teacher
Female		3	2	N/A
Female		2	0-1	N/A
Female		3	3	Self
Male	4+		0-1	N/A
Male		3	4	Teacher
Male		2	4	Self
Male		1	5	Teacher
Female		2	3	Teacher
Female		3	3	Teacher
Female		2	2	N/A
Female		3	2	N/A
Female		3	3	Teacher
Male		2	3	Teacher
Male		1	5	Teacher
Female		2	3	Teacher
Female		1	5	Teacher
Female		2	0-1	N/A

Female	4+	3	Self
Male	4+	2	N/A
Female	4+	2	N/A
Male	4+	4	Self

The after obtaining all of the data above it was decided to treat it first as numeric data, then subsequent to that treat it as categorical data. The first test that was run was a linear regression test:

The linear regression test is based exclusively on the formula $S_{xy}/(S_x)(S_y)$ where S_{xy} S_x and S_y are defined by the formulae below, X will be the number of advanced classes and Y will represent the number of hours studied per class per week.

$$S_{xy} = \frac{\sum (x - \bar{x})(y - \bar{y})}{n}$$

$$S_x = \sqrt{\frac{\sum (x - \bar{x})^2}{n}} \quad S_y = \sqrt{\frac{\sum (y - \bar{y})^2}{n}}$$

In order to accurately calculate the linear regression line it is mandatory that one calculates the average X and Y values, as have been calculated below and placed into a table where they begin in fractional form and are translated into decimal form then rounded properly.

X Average	653/215	3.037209302325581	≈ 3.04
Y Average	688/215	3.2	3.2

The S_{xy} Value is calculated below, ellipses are used to indicate that the pattern is continued for the 175+ bits of the equation that were left out for purposes of space. The $\sum (x - (\text{average of } x))$ is enclosed in the first set of brackets and the $\sum (y - (\text{average of } y))$ is enclosed in the second set of brackets, and those two summations are divided by "n" or 215

$$\frac{[(2-3.04)+(2-3.04)+(1-3.04)+(3-3.04)+(3-3.04)+(2-3.04)+(1-3.04)+\dots+(2-3.04)+(4-3.04)+(5-3.04)+(5-3.04)+(4-3.04)]*[(2-3.2)+(4-3.2)+(5-3.2)+(3-3.2)+(4-3.2)+(4-3.2)+(1-3.2)+\dots+(5-3.2)+(1-3.2)+(3-3.2)+(2-3.2)+(2-3.2)+(4-3.2)]}{215}$$

$$\frac{[(2-3.04)^2+(2-3.04)^2+(1-3.04)^2+(3-3.04)^2+(3-3.04)^2+(2-3.04)^2+(1-3.04)^2+\dots+(2-3.04)^2+(4-3.04)^2+(5-3.04)^2+(5-3.04)^2+(4-3.04)^2]}{215}$$

$$\frac{[(2-3.2)^2+(4-3.2)^2+(5-3.2)^2+(3-3.2)^2+(4-3.2)^2+(4-3.2)^2+(1-3.2)^2+\dots+(5-3.2)^2+(1-3.2)^2+(3-3.2)^2+(2-3.2)^2+(2-3.2)^2+(4-3.2)^2]}{215}$$

Sxy is then divided by [(Sy)(Sx)] and you achieve your linear regression line. The r value that was gathered from these formulae above (solved using a TI-84 calculator and Fathom Statistical Program) was -0.0137451, which according to the IB Math Studies book provided at Upper Arlington High School, is a "Very Weak" correlation. This r-value indicates that only 0.018893% of the variation in advanced can be attributed to Hours. The correlation is evidently microscopic. The hypothesis that appears to be supported by the provided data is that there is no relationship between the numbers of advanced (AP/IB or Honors) classes that a student takes, and the number of hours of homework per class per week. In order to draw conclusive evidence from this data it was decided to look at the data (specifically number of advanced classes taken, and number of hours of homework per class per week) from a categorical standpoint, using graphs, and a frequency table, as well as a chi-squared test. In order to allow for the chi squared test to be valid, in regards to no more than 20% of the expected values being less than 5 I collapsed the previous summary table down on the horizontal axis to have "4", "5", "6", "7", all become grouped under 4+. As well, on the vertical axis "Less than 1 hour" and "1" were

Altered Data.htm

		Advanced				Row Summary
		1	2	3	4+	
Hours	2	3	9	9	9	30
	3	4	15	17	16	52
	4	1	17	18	19	55
	5	8	7	15	17	47
	0-1	4	10	8	9	31
Column Summary		20	58	67	70	215

S1 = count()

collapsed into one row in order to be successful in creating validity in the chi-squared test. This can be seen on the figure on the bottom of the previous page, it is important to note that every chart, table, or test from this point on will use this refined set of data. Now that it was possible to have a chi-squared test without more than 20% of the expected values being less than 5, a chi-squared test was run using the Fathom Statistical Program and the results were gathered in the table on the subsequent page.

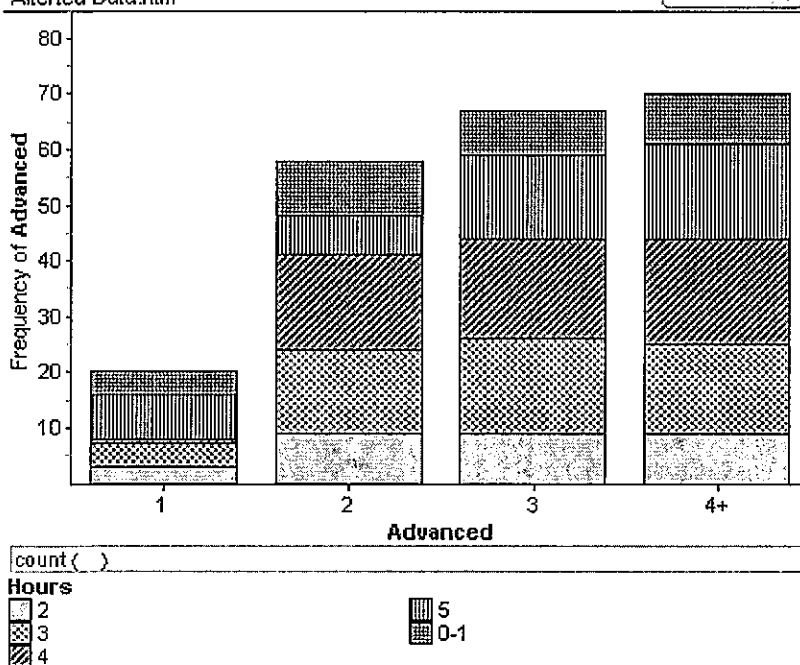
In order to complete a χ^2 it is necessary to write a null hypothesis, which is as follows:
There is no relationship between the number of advanced classes taken by a student at Upper Arlington High School, and the number of hours of homework they do per class per week.

The test will be performed at a 95% certainty level with degrees of freedom as 12.

All values for the chi-squared test are contained in the table on the right the numbers not in parenthesis in the grid, excepting the Row and Column summaries are the actual values for this test. The parenthetical numbers are all the expected values for every cell in the table. The test yielded a χ^2 value of 11.14 which was 9.886 below the critical value of 21.026 thus the null hypothesis must be accepted.

		Advanced				Row Summary
		1	2	3	4+	
Hours	2	3 (2.8)	9 (8.1)	9 (9.3)	9 (9.8)	30
	3	4 (4.8)	15 (14.0)	17 (16.2)	16 (16.9)	52
	4	1 (5.1)	17 (14.8)	18 (17.1)	19 (17.9)	55
	5	8 (4.4)	7 (12.7)	15 (14.6)	17 (15.3)	47
	0-1	4 (2.9)	10 (8.4)	8 (9.7)	9 (10.1)	31
Column Summary		20	58	67	70	215

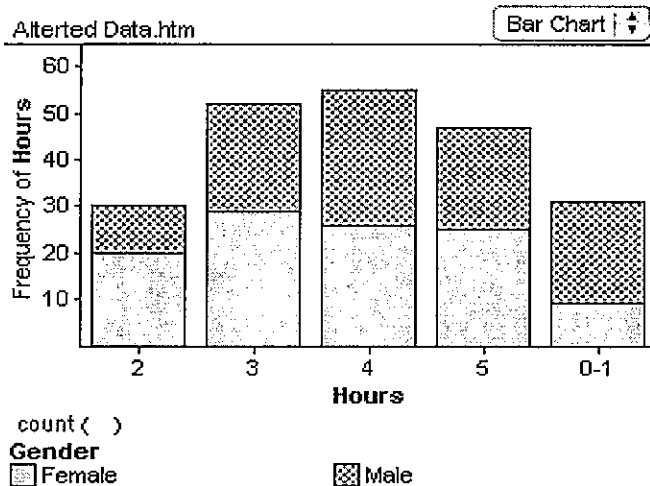
Altered Data.htm



This means there is no relationship between the number of advanced classes taken by a student at UAHS, and the number of hours of homework per class per week that is done. The bar graph to the left illustrates an iconic, less numerical display of the data at hand. It can be seen in the graph that there is only a negligible difference between the number of hours done (indicated by the legend at the base of the graph) on the separate bars that represent each level of amount of advanced classes taken by the students surveyed, this graph also is conclusive as there is not a significant difference in the proportions of numbers of hours to numbers of advanced classes.

Hard to tell without calculations 12

In order to examine Gender as a possible confounding variable all-relevant information was compiled into the summary tables and the graphical representations below. 109 females attending higher level or advanced level classes were surveyed and 106 Males surveyed, with only a +3 difference for females, the confounding variable of gender in both number of hours of homework...



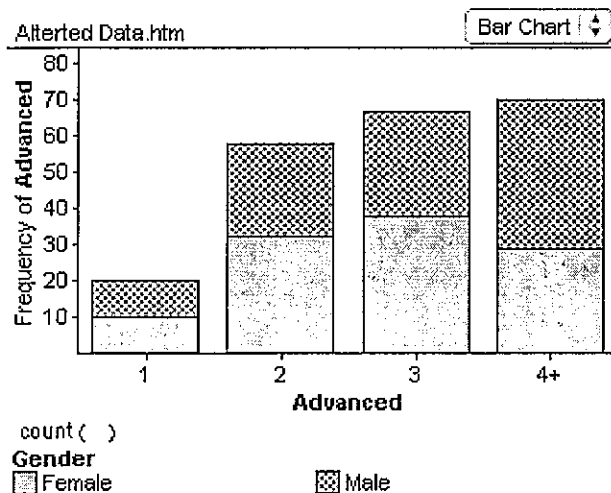
Altered Data.htm

		Gender		Row Summary
		Female	Male	
Hours	2	20	10	30
	3	29	23	52
	4	26	29	55
	5	25	22	47
	0-1	9	22	31
Column Summary		109	106	215

S1 = count ()

Why no comparisons here?
of losing proportions here?
looks like some interesting
differences by gender.

...And also in numbers of advanced classes taken:



Altered Data.htm

		Gender		Row Summary
		Female	Male	
Advanced	1	10	10	20
	2	32	26	58
	3	38	29	67
	4+	29	41	70
Column Summary		109	106	215

S1 = count ()

Conclusion/Validity:

The major conclusion that was found during this experiment was that there is a minimal, almost negligible correlation between the number of classes taken, and the number of hours of homework per class per week done. There were a few possible sources of error that could be assessed. Primarily, this survey was done in a short span of time, it was not distributed as a take home survey, and thus it was retrospective. Because this survey was retrospective it asked persons to gauge an estimate on the average number of hours of homework done per class per week, which also could lead to error, as a person may or may not be able to guess accurately. The surveys were done in a controlled no-talking environment in order to eliminate social-desirability bias, as well there were no space given for names in order to eliminate the possibility of other demand characteristics, such as the desire by a subject to be "good" and mark the answers that allowed the experimenter to receive, what the subject thinks, is the greatest results. Although a random sample with no incentive was taken as the best representation of the average Upper Arlington High School Student, gender was examined subsequent to the test to eliminate it as a confounding variable. As seen on page 13 males make up ~49.3% of the sample size, whereas females make up ~50.7% making the distribution almost perfectly split between the two genders. This was sufficient evidence to eliminate gender as a confounding variable that could possibly skew the data of this experiment.

As Pearson's correlation coefficient was found to be ~ 0.0137451 with a perfect positive correlation being 1, there was no relationship in purely numerical terms. In order to discern a relationship in categorical terms a chi-squared test was run. The test yielded a χ^2 value of 11.14 which was 9.886 below the critical value of 21.026 thus the null hypothesis, which said there was no relationship, was accepted.

Although the answer was a resounding no to a correlation between the number of advanced classes taken and the number of hours of homework per class per week, other questions relevant to this subject have been answered. It was found that students at UAHS, (an extrapolation was made from the surveyed sample) do on average, 3.2 hours of homework per class per week, which is .2 hours or 12 minutes above the imposed 3 hour limit, mandated by school administration. The difference may be small, and appear negligible, however the school's rational behind limiting the number of hours of homework was that however much time done after 3 hours a week was not beneficial according to a Harvard study that the administration often cited. These 12 minutes add up for the average student to be 36 wasted minutes a week (as the average student takes ~ 3 advanced classes so $12 \times 3 = 36$) which if multiplied by the average number of school days of 188 leads to 6,768 minutes wasted (188×36). Almost 113 hours of wasted time according to the guidelines and rational of Upper Arlington High School's administration. This is a significant find, as it gives empirical backing to a long held student belief that the so-called "3-hour policy" did not hold up in reality. This point however leads me to my next issue with validity.

* A rather strong term here.

When dealing with any population it is necessary to look at the nature of the subjects in addition to the context in which the survey was given. Students, however reliable, tend to be either "hypobolic" or hyperbolic with their estimations of the level of homework that they do each night when asked for an average, because they are biased by the most recent workload. The survey was taken by all subjects subsequent to midterm exams, during the period of catharsis, so to speak. There was a winding down period as semester (midterm) exams took place prior to the end of the semester so classes began wrapping up after the test. This environment of colloquial "wrap-up" could lead to a decrease in homework, which in turn could bias students to estimate lower than normal averages when asked for a total average on the number of homework done per class per week. A more accurate way to complete this experiment in the future would be to give a log to students during different possible periods of high and low homework (low meaning in the "catharsis" period and high meaning perhaps directly prior to exams) and average the number of hours per class per week written by the student in his or her log. However this was impractical for the project at hand because, with no mandate from authority and without other incentive, it would not be possible to gather information from 215 students as was done in this experiment.

Good point

In executive summation, the final answer given in response to the research question, by this survey project, was that, no, in fact there was no relationship between the number of advanced level (AP/IB or Honors) courses taken by a student, and the number of hours done per class per week by a student. A number of possible issues with validity have been discussed above, but I believe that this project was valid on the whole, given a large sample size that was almost evenly distributed between gender, and totally random.



5/PJCS

Individual project coversheet: mathematical studies SL

Submit to: Moderator

Arrival date: 20 Apr / 20 Oct

Session:

School number:

001440

School name:

Upper Arlington High School

• Write legibly

• Complete the

• Complete the

• ink and retain a copy of this form.

• use of your school (English, French or Spanish).

Candidate name

Candidate session number:

00111111

Title of project:

Is More More, or is More Less?

Assessment criteria:

Criterion	Comments	Achievement level		
		Teacher	Moderator	Senior moderator
A Introduction	Thorough description & statement of task	0-2 2	<input type="checkbox"/>	<input type="checkbox"/>
B Information/measurement		0-3 3	<input type="checkbox"/>	<input type="checkbox"/>
C Mathematical processes	A more thorough look at the gender relationships needed to get to a 5.	0-5 4	<input type="checkbox"/>	<input type="checkbox"/>
D Interpretation of results	Quite comprehensive & accurate interpretations.	0-3 3	<input type="checkbox"/>	<input type="checkbox"/>
E Validity	Very thoughtful response.	0-2 2	<input type="checkbox"/>	<input type="checkbox"/>
F Structure and communication	Just a few minor details	0-3 3	<input type="checkbox"/>	<input type="checkbox"/>
G Commitment	Abs met all project deadlines	0-2 2	<input type="checkbox"/>	<input type="checkbox"/>
		0-20 Total 19	<input type="checkbox"/>	<input type="checkbox"/>

I confirm that, to the best of my knowledge, the material submitted is the candidate's own work.

Teacher's name:

James Kenny

Date:

3-9-10

Teacher's signature:

James Kenny

Candidate declaration: I confirm that this work is my own work and is the final version. I have acknowledged each use of the words or ideas of another person, whether written, oral or visual.

Candidate's signature:

Date: